

Appendix F



Microsoft Windows CE: A New Handheld Computing Platform

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Abstract

This paper describes the goals and key features of Microsoft Windows CE. Windows CE is the system and application software for a new class of computer, the handheld PC, or HPC. Microsoft produced the operating system, shell, and a suite of standard applications. The Windows CE team worked closely with several hardware manufacturers as they designed their HPC devices to ensure the best possible integration of hardware and software.

Product Goals

The Windows CE design was founded on reaching three primary goals. These were:

1. Not be a PDA. The Windows CE team rejected the ambitious vision of PDAs such as the Newton and Magic Cap. So Windows CE does not try to be your assistant; rather it is just a useful tool. Handwriting recognition was also rejected for the first release (although recognizers are available from two vendors). The most successful existing handheld computers (HP 200LX, Psion 3a, Sharp Zaurus) all featured keyboards as the primary (or only) data entry mechanism. Thus the device on which Windows CE would run was called a "handheld PC". Finally, a "stealth" marketing approach was adopted. The feeling was that almost any marketing "hype" would be fatal to the product.
2. Be a companion to the Windows desktop. The target customer for Windows CE is someone who uses Microsoft Windows. Thus it is essential for Windows CE to leverage the user's knowledge and experience in using Windows and its applications. It is also critical that the user's data be easily moved between the desktop PC and the Windows CE device. A user should simply have to plug the handheld PC into the docking cradle and all data would be synchronized.
3. Deliver a device with a street price of \$500. Market research conducted by the team in 1995 revealed this as a critical number. A product delivered at a price above this was predicted to face considerable consumer resistance. And indeed, the existing PDAs priced

above \$500 have not sold well. To achieve this goal, the Windows CE team worked closely with the initial OEMs to ensure their designs could be delivered at the desired price.

Hardware

Part of the definition of a computing platform is that it be available from multiple hardware vendors. This is the case with Windows PCs, and it is the case with Windows CE. Like Windows NT, Windows CE was designed to support several different processors. The initial product supports, two, the Hitachi SH3 32-bit RISC processor, and the MIPS R4000 family of 32-bit RISC processors. Other 32-bit processors can be readily supported.

A typical handheld PC is quite similar to existing products such as the HP 200 LX, the Psion 3a, or the Sharp Zaurus. It is of clamshell design, with a 60-key keyboard. Physical size is about 3 3/4" x 7" x 1", and it weighs about .75 lb. with two AA batteries installed. The screen is a gray scale 240 x 480 LCD screen, with two bits per pixel. This provides for colors: black, white, and two shades of gray. Some of the devices have backlit screens. Instead of a mouse or other pointing device, the screen has a resistive touch surface. This allows the user to use a simple plastic stylus or the finger to select and operate on screen objects.

Operating System

The Pegasus operating system is the smallest member of the Windows family of operating systems. Like Windows NT, it is a fully 32-bit, multitasking, multithreaded system that runs on multiple CPU architectures. Yet the kernel occupies only 64K bytes of ROM, and the system plus multiple application programs can run in less than 400K bytes of RAM. The kernel supports a single address space, with process protection. Up to 32 concurrent processes are supported, and each process may have as many threads as available memory permits. The operating system and all built-in applications execute in place from ROM.

Built-in support is provided for communications with other handheld PCs, the desktop PC, and the Internet. IrDA is used for infrared inter-machine communications, while Sockets, TCP/IP, and PPP provide desktop and Internet access. A subset of PCMCIA card and socket services support modems. Support for installable client drivers is also provided.

The Windows CE operating system implements an object store that is exposed to applications through three interfaces. The first is the native Windows CE database, and the API set is exclusive to Windows CE. The other two APIs are the

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Win32 file system and Registry APIs, and Windows CE implements a large subset of those found on Windows 95 or Windows NT.

Finally, a set of RPC calls are supported to facilitate desktop application programs that communicate with Windows CE while it is docked. Through this interface, a desktop program has access to all of the database, file system, and Registry calls.

User Interface

Windows CE is instantly recognizable as a member of the Windows family. It includes key Windows 95 components as the taskbar with its enunciator and start button, the start menu, the desktop explorer, and shortcuts.

This key design point has been repeatedly validated in focus groups and extensive usability testing. The comment we hear is, "I already know how to use it!", and we repeatedly observe Windows users new to Windows CE immediately begin to use it without any introduction. We believe Windows CE will have a shorter learning curve and offer greater leverage of users' existing Windows PC knowledge than any other handheld computer. In addition, its position as a new platform is strengthened as Windows CE extends the industry-standard operating system to the handheld market for the first time.

Compatibility with Windows 95 extends beyond the operating system to the applications. Whenever possible, Windows CE applications look, feel, and work like their desktop counterparts.

Built-in Applications

Windows CE comes with a rich set of applications resident in ROM. All of them were written by the members of the Windows CE team. The applications include:

- A personal information manager, comprised of three components, Contacts, Calendar, and Tasks. The Windows CE PIM is a subset of Microsoft Schedule+ on the desktop. When the Windows CE is connected to the desktop, changed data in any of the components is automatically synchronized with that on the desktop.
- Companions to Microsoft Word and Microsoft Excel. Each of these programs is a small subset of its desktop counterpart, but implements the most-used features. Transfer and translation of documents between the handheld PC and desktop is a simple drag and drop operation. As the data conversion from the desktop to Pegasus is a lossy operation, automatic synchronization is not supported here.
- A subset of Microsoft Internet Explorer. It automatically shrinks graphics and converts color spaces to maximize their readability on the handheld PC screen.
- An inbox that provides electronic mail access to any server that supports SMTP and POP3. It provides APIs to allow transports to be developed by third parties to extend its reach.
- Solitaire. It wouldn't be Windows without it.

SDK and Development Environment

The Windows CE SDK provides software developers with everything needed to write application programs for Windows CE. The SDK is delivered as extensions to the Microsoft Visual C++ development environment, and thus, in comparison with other handheld computers, is extremely comprehensive, robust, and mature. Windows programmers who are familiar with the Win32 API will find a very familiar environment here. Our experience has been that the learning curve for programming for Windows CE is measured in hours.

Windows CE provides a large subset of the Win32 API. Most of the standard functions are there, but some major subsystem APIs are missing, as they are not supported on Windows CE. These include MFC, security, MAPI, ODBC, OLE, DirectX, and so on. In addition, there are some new Windows CE-specific APIs that support the features of this new platform. These include the Windows CE database, address book, notifications, mail client, and PCMCIA card drivers.

Programmers develop Windows CE applications at a Windows NT desktop computer. Here the Windows CE SDK provides a very faithful emulation of the Windows CE operating system, so that most of the program development can take place entirely on the NT system. Of course, performance and hardware-specific features are not emulated. It is our experience that about 90% of the application development process can take place entirely in emulation.

The Windows CE SDK provides cross compilers for both supported processors. As part of the build process, executables are automatically downloaded to the retail Windows CE device connected to the NT desktop via a serial cable. Remote debugging is supported from the development environment, along with other remote tools such as Spy (views messages), Zoomin (expands and captures screen images), RegEdit (edits the Registry), MemView (views memory), and Pview (displays process status). The remote object store browser lets developers view and manipulate data residing in the object store or file system, on both the real and emulated Windows CE.

As of this writing (November, 1996), over 600 independent software vendors are developing applications for Windows CE.

Currently you must use C or C++ to develop applications for Windows CE. Support for Java is currently under development, and support for Visual Basic is a future objective.

Summary

Windows CE is designed to be a platform; the newest member of the Windows family of operating systems. Its true success will come if it is able to grow the handheld computer market to the point where most professionals view a handheld computer as an essential business tool.

More information on Windows CE is available at <http://www.microsoft.com/windows/windowsce>.